Fish Tissue Contaminants Index

National estuarine condition as measured by fish tissue contaminants is poor based on the NCA survey alone; however, incorporating information from the Great Lakes region (Chapter 7) increases the national ranking from poor to fair. Figure 2-17 shows that 22% of all sites sampled through the NCA survey showed contaminant concentrations in fish tissues above EPA guidelines. This percentage may have been increased in part due to the use of juvenile fish rather than fish of commercial size. In most states, NCA surveys collected fish for analysis of whole-body burdens of contaminants (i.e., contaminants from the entire fish—fillets, head, skin, organs). The use of juvenile-sized fish could increase the likelihood of higher, whole-body concentrations of contaminants, especially for those contaminants not found in muscle tissue. In a few states, both edible fillets and whole-body burdens were examined. EPA Guidance describing risk-based concentrations of concern for recreational and subsistence fishers (U.S. EPA, 2000c) applies to fillet, whole-body, and organ-specific concentrations. Whole-body contaminant concentrations for many contaminants (e.g., pesticides, cadmium, PAHs) are higher than the concentration in muscle tissue (fillets); however, mercury concentrations can be severely underestimated using the whole-body concentration data. For example, mercury concentrations can be three to five times more concentrated in muscle tissue than in whole-body samples. About one-third of coastal states often use whole-body concentrations to set advisories for waters where consumer groups eat whole fish. Few contaminant guidelines exist for wildlife protection.

The NCA survey data examined whole-body composite samples (5 to 10 fish of a target species per site) for 90 specific contaminants from 653 sites throughout the estuarine waters of the United States (except from Louisiana, Florida, and Puerto Rico). For most contaminants, whole-body concentrations overestimate the risk of consuming only the fillet portion of the fish unless the contaminant is concentrated in muscle tissue (e.g., mercury), and the findings should be considered accordingly. In addition, most analyses were conducted on juvenile fish (non-market-size fish),

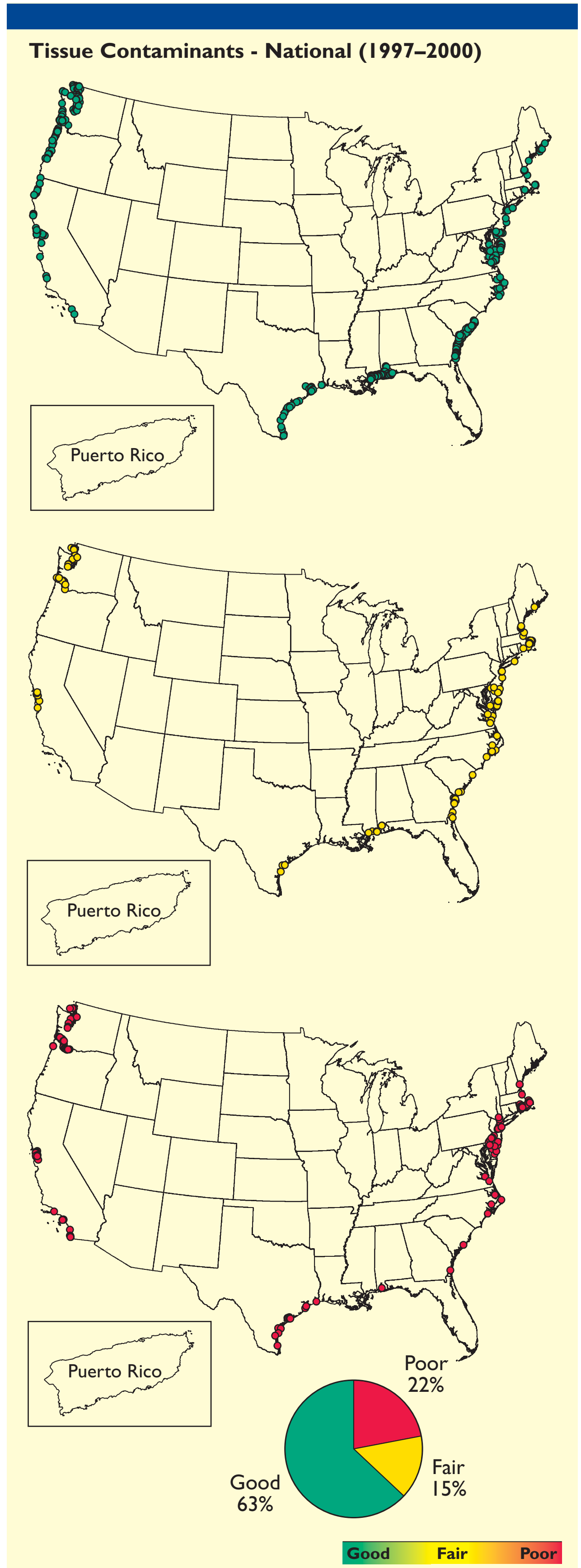


Figure 2-17. National fish tissue contaminants index data (U.S. EPA/NCA).

which are known to have accumulated contaminant levels that are lower than those in larger, market-sized fish.

The whole-body contaminant concentrations in fish and shellfish were compared with the range of concentrations for EPA guidelines. At least one of the analyzed contaminants exceeded the maximum of the range in 22% of estuarine waters sampled in the United States (Figure 2-17). An additional 15% of estuarine waters had fish or shellfish tissue concentrations within the noncancer range for at least one contaminant. Areas of poor and fair condition were dominated by total PCBs (39%), total DDT (16%), total PAHs (6%), and mercury (1%). Fish and shellfish analyzed included Atlantic croaker, white perch, catfish, flounders, scup, blue crab, lobster, shrimp, whiffs, mullet, tomcod, spot, weakfish, halibut, soles, sculpins, sanddabs, basses, and sturgeon. In the Northeast Coast region, 31% of sites where fish were captured were in poor condition, and 29% were in fair condition (the Northeast Coast was the only region that showed poor or fair condition for more than 50% of the sites yielding fish). Exceedances in the Northeast Coast region occurred largely for total PCBs (51%), PAHs (14%), DDT (9%), and mercury (3%). In West Coast estuaries, 27% of sites where fish were captured were in poor condition, and 11% were in fair condition, with exceedances primarily seen in total PCBs (30%) and DDT (17%). Approximately 90% of these sites were in San Francisco Bay, the Columbia River, and the Puget Sound system. Exceedances in Gulf Coast estuaries occurred at 22% of sites, primarily for PCBs (16%) and DDT (10%).

A factor of three was used to correct whole-body concentrations of mercury to approximate fillet concentrations, based on a comparison of the ratio of whole fish to fillet mercury concentrations found in scientific literature, and 42% of estuarine sites that yielded fish in the United States exceeded EPA Guidance values for mercury (Table 2-3). These exceedances included 48% of estuarine sites where fish were captured in the Northeast Coast, 43% in the West Coast, 18% in the Gulf Coast (excluding Florida and Louisiana), and 10% in the Southeast Coast.

Table 2-3. Projected Exceedances of Noncancer Health Endpoints for Associated Four 8-Ounce Fillet Meals per Month for Mercury (Based on Three Times the Observed Whole-Body Concentrations) (U.S. EPA/NCA).

Region	Proportion of Region within the Concentration Range (0.12–0.23 ppm)(Fair)	Proportion of Region above the Upper Limit of the Concentration Range (> 0.23 ppm)(Poor)	Proportion of Region in Poor and Fair Condition
Northeast Coast	34%	14%	48%
Southeast Coast	7%	3%	10%
Gulf Coast	12%	6%	18%
West Coast	19%	24%	43%
Total United States	24%	18%	42%

The snook (*Centropomus undeimalis)* is popular in the recreational fishing industry of the Florida Keys. This species, usually found in the Florida Bay and around the mangroves of the Keys, has also been spotted out on the reef. (photo: Bob Care - Florida Keys NMS)

Large Marine Ecosystem Fisheries

As of 2001, many marine fish stocks in LMEs around the country were healthy, and other stocks were rebuilt. Despite this progress, a number of the nation's most significant fisheries face serious challenges, including West Coast groundfish, the Southeast Coast snapper-grouper complex, and Northeast Coast mixed species.

In 2001, NOAA's Office of Sustainable Fisheries reported on the status of 595 marine fish and shellfish stocks out of 951 total stocks (NMFS, 2002). Eighty-one stocks were overfished (compared with 92 in 2000), and 67 of these (83%) were steadily rebuilding. Twenty more stocks in 2001 had sustainable harvest rates than stocks in 2000. Sixty-five stocks experienced catches exceeding allowable harvest levels. The NMFS has approved rebuilding plans for the majority of overfished stocks. Of the 81 stocks that are overfished, 67 have an approved rebuilding plan, and 9 have plans under development.

Recovery from Biomass Depletion in Large Marine Ecosystems

Mandated management actions of the Northeast Shelf LMEs are reversing declines in biomass yields that have occurred over the last several decades. Since 1994, reductions in fishing effort increased the spawning stock biomass levels of cod, haddock, yellowtail flounder, and other species in the U.S. Northeast Shelf ecosystem.

In the 1990s, herring and mackerel stocks began to recover and establish higher stock sizes. This recovery was due in part to a decrease in the amount of foreign fishing for these species, as well as to more than a decade of low fishing mortality. Bottom trawl survey indices for both species increased dramatically, with more than a tenfold increase in abundance (average of 1977–1981 vs. 1995–1999) by the late 1990s. Stock biomass of herring increased to more than 2.5 million mt by 1997. For mackerel, total stock biomass has continued to increase since the closure of the foreign fishery in the late 1970s. Although absolute estimates of biomass for

Top 10 Commercial Species Landed in 2001

	Top 10 by Quantity		Top 10 by Value	
Rank	**Species**	**Metric Tons**	**Species**	**Dollars (thousands)**
1	Pollock	1,446,260	Shrimp	$568,547
2	Menhaden	789,900	Crabs	$381,667
3	Salmon	327,870	Lobsters	$275,728
4	Cod	229,028	Pollock	$236,923
5	Hakes	225,504	Salmon	$208,926
6	Flounders	159,830	Tunas	$207,300
7	Shrimp	147,182	Scallops	$175,416
8	Tunas	150,185	Clams	$161,992
9	Herring	136,300	Cod	$150,157
10	Crabs	123,490	Halibut	$115,169

Recreational Fishing Statistics for 2001

12.1 million anglers: 52% Atlantic, 25% Gulf of Mexico, 21% Pacific (excluding Alaska), 2% Puerto Rico

86.8 million trips: 61% Atlantic, 26% Gulf of Mexico, 11% Pacific, 2% Puerto Rico

444.2 million fish caught: 55% Atlantic, 36.5% Gulf of Mexico, 8% Pacific, 0.5% Puerto Rico

Source: NMFS, 2002

the late 1990s are not available for mackerel, recent analyses place the stock at or near a historic high in total biomass and spawning stock biomass. In addition, recent evidence indicates that, following mandated substantial reductions in fishing effort, both haddock and yellowtail flounder stocks are responding to the catch reductions favorably, with substantial growth reported in spawning stock biomass size since 1994 for both species. In addition, a very strong year-class of yellowtail flounder was produced in 1998, and a strong year-class of haddock was produced in 1999 (see Figure 2-18).

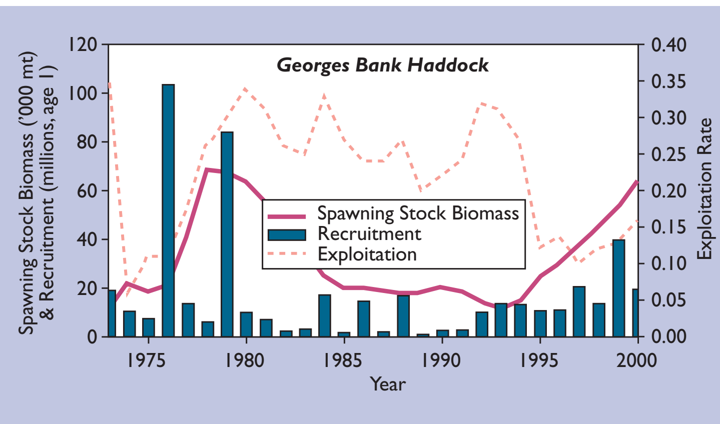


Figure 2-18. Spawning stock biomass, recruitment, and exploitation rate of Georges Bank haddock (Sherman et al., 2002).

During the last two decades, herring and mackerel stocks have undergone unprecedented levels of growth, approaching an historic high in combined biomass. This growth is taking place during the same period that the fishery-management councils for the New England and Mid-Atlantic areas of the Northeast Shelf LME have sharply curtailed fishing effort on haddock and yellowtail flounder stocks. Studies of primary productivity and zooplankton biomass suggest that there are ample food resources for these stocks. The "carrying capacity" of zooplankton that support herring and mackerel stocks and larval zooplanktivorous haddock and yellowtail flounder appears to be sufficient to sustain the strong year-classes reported for 1998 (yellowtail flounder) and 1999 (haddock).

The zooplankton component of the Northeast Shelf LME is in robust condition, with biomass levels at or above the levels of the long-term median values of the past two decades. This zooplankton community provides a suitable prey base for supporting a large biomass of pelagic fish (herring and mackerel), while providing sufficient zooplankton prey to support strong year-classes of recovering haddock and yellowtail flounder stocks. No evidence has been found in the fish, zooplankton, temperature, or chlorophyll component to indicate any large-scale oceanographic regime shifts of the magnitude reported for the North Pacific or Northeast Atlantic Ocean areas.

Assessment and Advisory Data

Clean Water Act Section 305(b) Assessments

Twenty-three of the 27 coastal states and territories (hereafter, states and territories will be referred to as states), the District of Columbia, the Commonwealth of the Northern Mariana Islands, and the Delaware River Basin Commission rated general water quality conditions in some of their estuarine waters. Altogether, these states assessed 31,072 square miles of estuarine waters, or 36% of the 87,369 square miles of estuarine waters in the nation. Of these 27 coastal states, 14 rated general water quality conditions in some of their coastal waters. They assessed 3,221 miles of ocean shoreline, representing 5.5% of the nation's coastline (including Alaska's 36,000 miles of coastline), or 14% of the 22,618 miles of coastline excluding Alaska.

The states reported that 45% of their assessed estuarine waters have good water quality that fully supports designated uses (Figure 2-19). Of the assessed waters, nearly 4% are threatened for one or more uses.

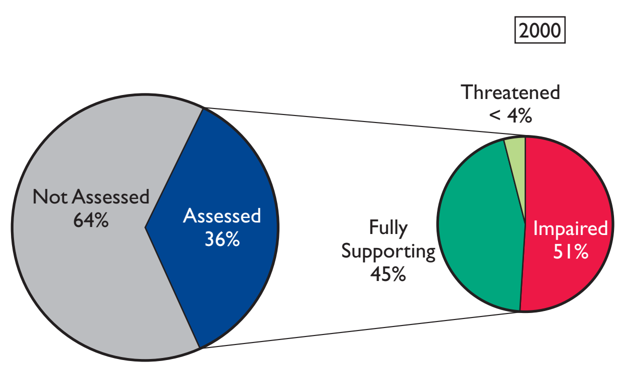


Figure 2-19. Water quality in assessed estuaries of the United States (U.S. EPA, 2002).

Supporting		These waters meet applicable water quality standards, both criteria and designated use.
Threatened		These waters currently meet water quality standards, but states are concerned that they may degrade in the near future.
Partially Supporting		These waters meet water quality standards most of the time, but exhibit occasional exceedances.
Not Supporting		These waters do not meet water quality standards.

Some form of pollution or habitat degradation impairs the remaining 51% of assessed estuarine waters. Most of the assessed ocean shoreline miles (2,755 miles, or 86%) have good quality and support a healthy aquatic community and public activities (Figure 2-20). Of the assessed waters, 79% fully support designated uses and 7% are threatened for one or more uses. Some form of pollution or habitat degradation impairs the remaining 14% of the assessed shoreline.

After comparing water quality data with water quality standards, states and tribes classified the waters into the following categories:

For the purposes of this report, waters classified as partially supporting or not supporting their uses are categorized as impaired. Twenty-two states reported the individual use support of their estuarine waters (Figure 2-21). States also provided limited information on individual use support in coastal waters (Figure 2-22). General conclusions cannot be drawn from such a small fraction of the nation's coastal waters. Significantly, 11 states had adopted statewide coastal fish consumption advisories for mercury, PCBs, and other pollutants as of the 2000 305(b) reporting period. These advisories are not represented in the use support numbers.

The major stressors that impair assessed estuarine waters are metals, pesticides, oxygen-depleting substances, toxic chemicals, PCBs, and dissolved solids. The states reported that pathogens, oxygen-depleting substances, turbidity, suspended solids, oil and grease, metals, and nutrients are the major stressors causing impairment to assessed ocean shoreline miles.

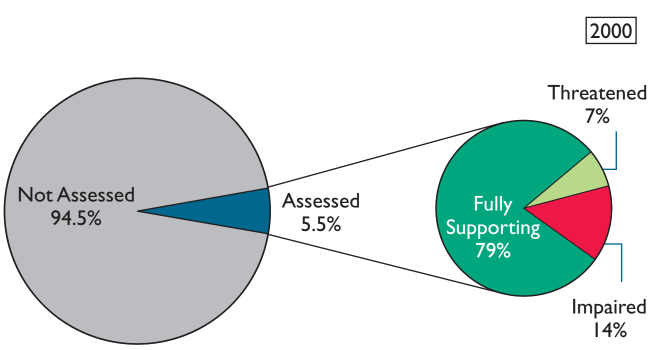


Figure 2-20. Water quality in assessed shoreline waters of the United States (U.S. EPA, 2002).

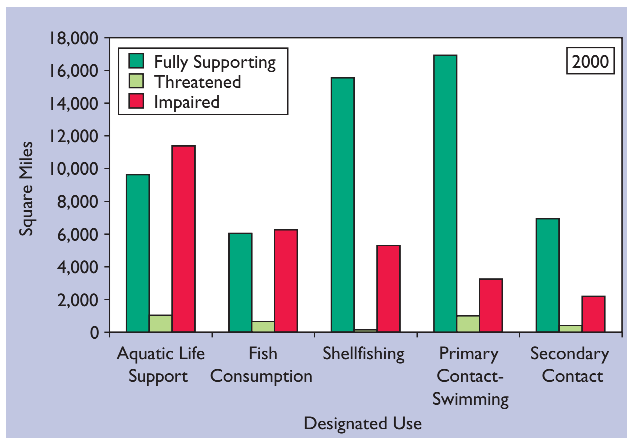


Figure 2-21. Individual use support for assessed estuaries of the United States (U.S. EPA, 2002).

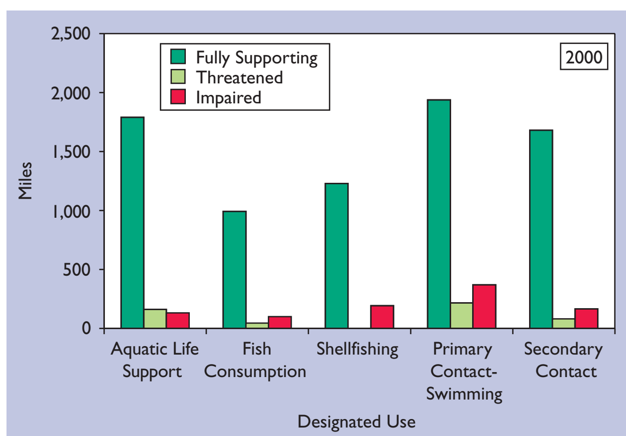
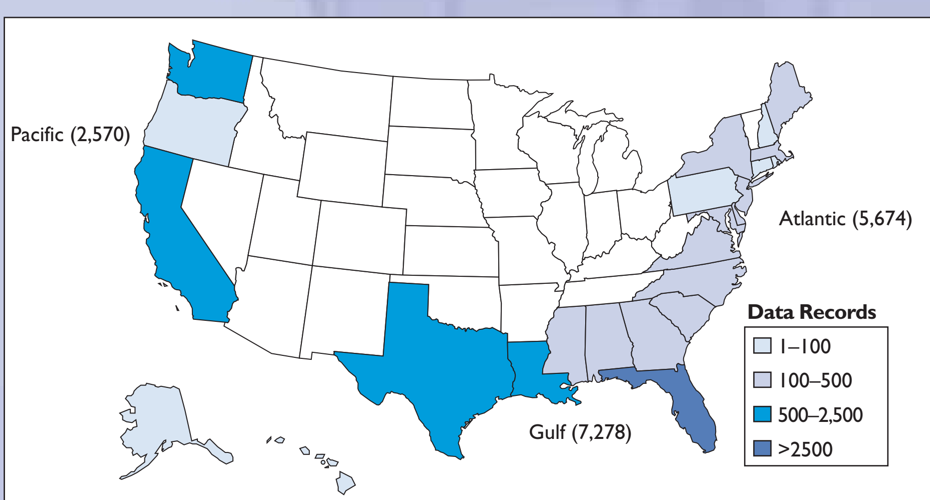


Figure 2-22. Individual use support for assessed shoreline waters of the United States (U.S. EPA, 2002).

Mercury in Marine Life – A Complex Story

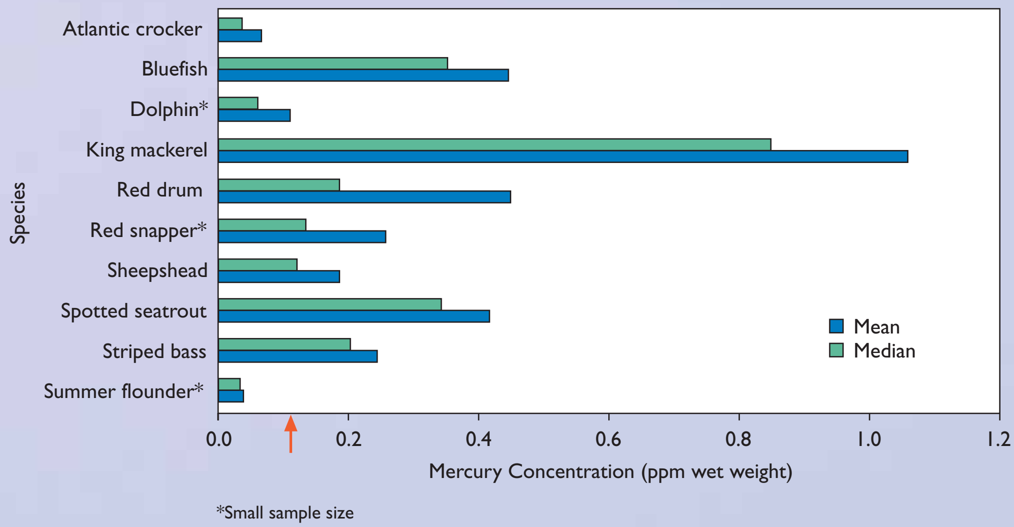
How big a problem is mercury in marine life? Although scientists do not know how much of a problem mercury in marine life poses to humans, they do know that mercury in the human diet comes primarily from fish. Exposure to too much mercury via fish consumption can lead to neurological effects in the developing fetus, children, and adults and can increase the risk of heart disease in adults. Scientists also know that some of the larger predatory fish commonly consumed by humans, such as sharks, swordfish, and king mackerel, have high levels of mercury in their tissues. It is uncertain, however, whether these concentrations are getting higher or lower over time, because there is no national baseline for mercury concentrations in saltwater species.

How do we characterize the transport of mercury in estuarine and marine environments? First, although atmospheric deposition is not the only source of mercury in estuaries and coastal waters, it is a primary source. Mercury that is deposited in estuaries and coastal waters may have originated as air emissions from a nearby source, from a source within the state, from a regional source outside the state, or from a source outside the country, and identifying the correct source can be difficult. Second, conditions in the sediments in coastal areas affect the speed at which inorganic mercury is converted to methylmercury, the most toxic chemical form of mercury that enters the food chain. Scientists are currently unable to determine which coastal areas are more likely to produce methylmercury at high rates and which will have relatively low rates. Unfortunately, even less is known about how mercury is transformed in the deep ocean. Third, although there is some information on the concentrations of mercury in fish and shellfish species, the migratory nature of many marine species requires additional information on where particular species feed and what they eat in order to determine how they are exposed to mercury. Finally, fish move globally in international commerce. Fish consumed in the United States may have been harvested in a foreign country, and fish that people in other countries consume may have been harvested in U.S. waters.



States with data in the Mercury in Marine Life Database (U.S. EPA, 2003b).

What kind of monitoring data do we have? Many of the data collected on mercury from long-term monitoring programs are collected by sampling small fish that serve as prey for larger commercial and recreational species. Although the mercury concentrations are not very high in these small fish, concentrations are higher in the larger predator fish that consume these small fish, and these larger fish are typically the fish preferred by people. Data collected from a variety of sources—5 federal, 4 regional, and 26 state monitoring programs—and assembled by EPA provide a recent snapshot of mercury concentrations in fish and shellfish. The data show that mercury concentrations are relatively high in some species popular among recreational fishers, but data are limited or unavailable for several popular recreational species. In addition, the data show that less information is available for many of the popular commercial species.



Mercury concentrations in the top 10 recreational species in the United States. The arrow at 0.12 ppm represents the lower acceptable concentration limit based on EPA Guidance for consumption of 4 meals/per month (U.S. EPA, 2003b).

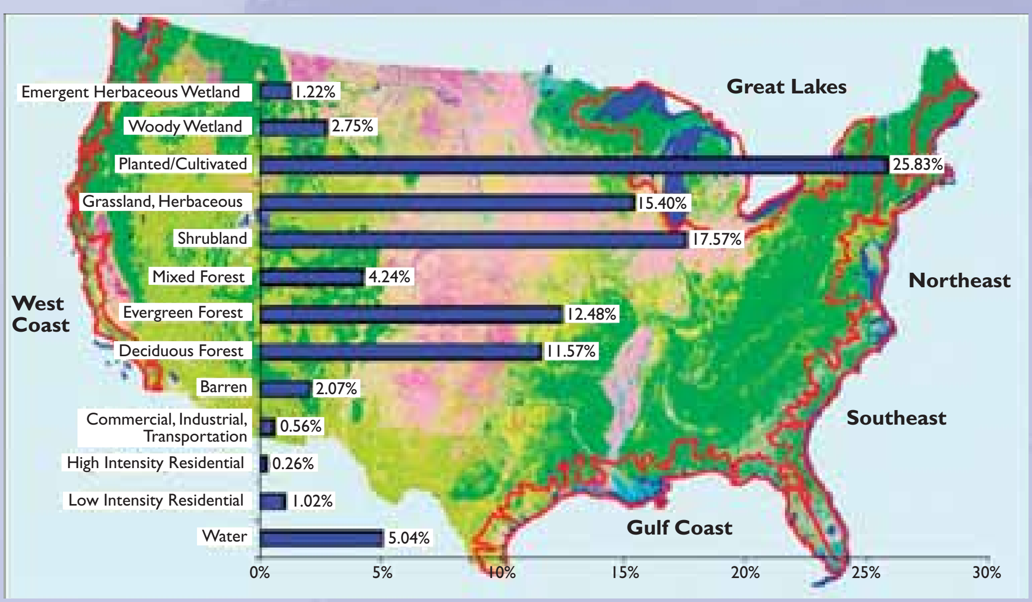
What does it mean? For samples of king mackerel collected on the Atlantic and Gulf of Mexico coasts combined, the mean and median mercury concentrations are 1.06 and 0.85 ppm mercury (wet weight), respectively. These are some of the higher concentrations observed in recreational species; however, this is only a starting point. Scientists still need to understand how the mercury is getting into these fish. That is why understanding how mercury is transported among organisms in the marine environment is a complex challenge.

For more information about the data set, contact John Wilson at wilson.john@epa.gov.

National Land Cover Data

The USGS and EPA created a nationwide land cover data set, National Land Cover Data (NLCD), for the conterminous 48 states based on early to mid-1990s, 30-meter Landsat Thematic Mapper satellite imagery. This NLCD was initially created to meet the needs of six federal environmental monitoring programs that formed a partnership called the Multi-Resolution Land Characterization Consortium. The consortium consists of agencies that produce or use land cover data as part of their missions: USGS, EPA, NOAA, USDA, and the U.S. Forest Service (USFS), the National Aeronautics and Space Administration (NASA), and the Bureau of Land Management (BLM). In addition to these federal agencies, other federal, state, and local government agencies and various environmental groups require recent intermediate-scale land cover data to perform their missions. Before the NLCD was created, USGS had compiled an intermediate land cover data set for the conterminous 48 states based on 1970s aerial photography. Although the 1970s data set can still be used for some applications, many land cover changes have taken place over the past 20 or more years. The NLCD provides a relatively current, consistent, and accurate land cover data set for a variety of applications: calculating land cover statistics, planning land use, deriving landscape pattern metrics, developing land management policies, and assessing ecosystem status and health.

The NLCD consists of 21 classes of land cover categories applied in a consistent manner across the 48 states (http://landcover.usgs.gov/index.asp). The NLCD developers established standard procedures to classify the Landsat Thematic mapper satellite imagery that was used, in conjunction with ancillary data sets, to refine the classification process.



NLCD data for the 48 conterminous states, with a chart depicting percentage of total land cover for selected categories (USGS, 1999).

Total acreage values were calculated for the conterminous 48 states based on the NLCD's 21 classes. The area and percentage of the national total for five land cover categories (low intensity residential; high intensity residential, commercial, industrial, and transportation; woody wetland; and emergent herbaceous wetland) are summarized in the table at right.

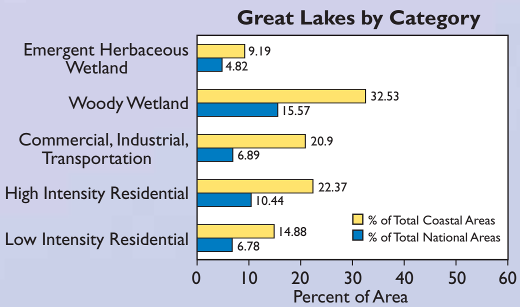
Land Cover Area Totals

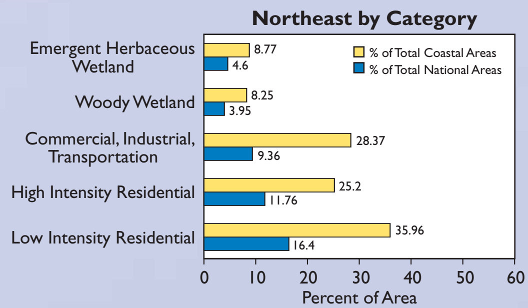
Category Land Cover	Square Miles	Percentage of National Total Area
Low-intensity residential	31,696.13	1.02
High-intensity residential	8,127.12	0.26
Commercial, industrial, transportation	17,550.95	0.56
Woody wetland	85,419.40	2.75
Emergent herbaceous wetland	37,984.70	1.22

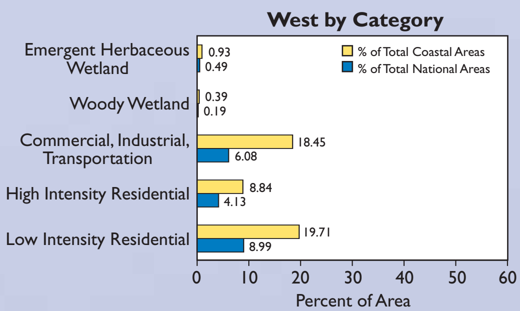
Source: USGS, 1999

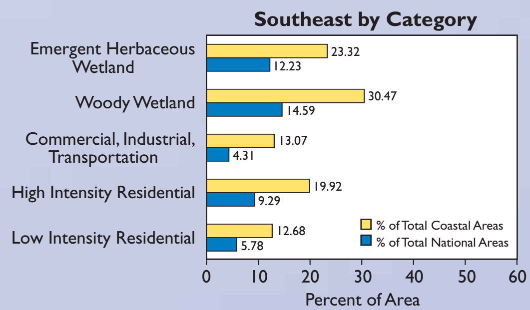
For the NCCR II, areas of interest were extracted and evaluated for the five coastal regions (outlined in red on the map) of the conterminous 48 states. Analyses and comparisons can be made within and among these regions. The five land cover categories highlighted comprise only 5.81% of the total national land cover; however, these highlighted categories are well represented in the nation's coastal regions. The bar graphs show that the combined coastal regions account for the following percentages of the nation's land cover totals, reported by category: 32.97% of commercial, industrial, transportation; 46.67% of high-intensity residential; 45.6% of low-intensity residential; 52.45% of emergent herbaceous wetland; and 47.87% of woody wetland.

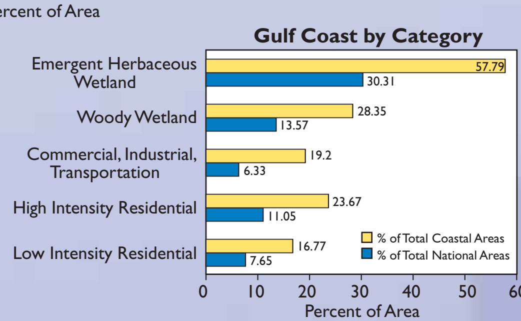
For more information about the NLCD, contact Jimmy Johnston at jimmy_johnston@usgs.gov.











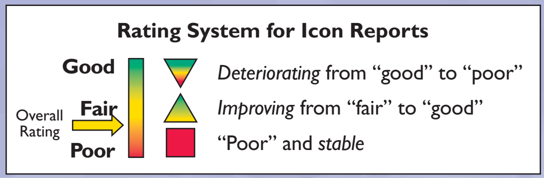
Source: USGS, 1999

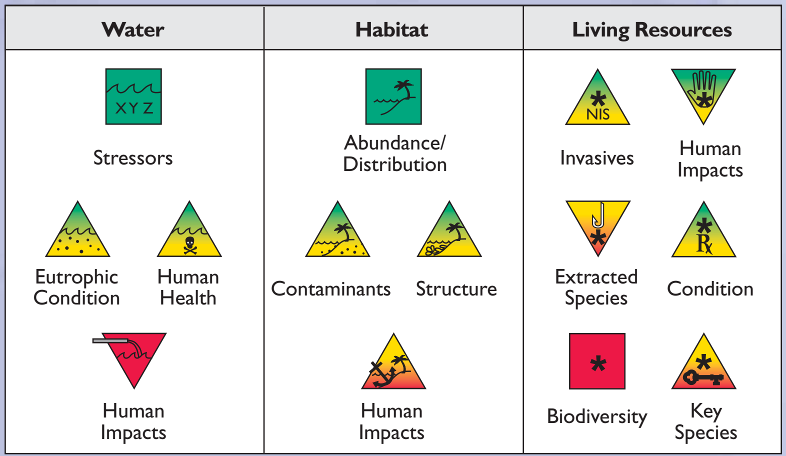
Monitoring in the National Marine Sanctuaries

The National Marine Sanctuary Program is developing a System-Wide Monitoring Program (SWMP) for the nation's 13 marine sanctuaries. The goal of the SWMP is to provide a consistent approach to the integrated design, implementation, and reporting of environmental data from individual sanctuaries, sanctuary networks, and the sanctuary system as a whole. The design process allows for tailored monitoring in all sanctuaries, developing information critical to management while contributing to and benefitting from other local, regional, and national monitoring programs. It also provides a means to design monitoring programs to address networks of sanctuaries, specific issues, or resource types. Driven by scale-specific questions based on existing threats to water quality, habitat and living resources, as well as system questions applicable at all sanctuaries, monitoring programs will be developed and implemented at multiple spatial scales, with priority given to sanctuary-based monitoring.

Key partners operating at relevant spatial scales will support the programs. Local, regional, and national reports will document results at appropriate levels of specificity and incorporate an icon-based scheme to summarize the status and trends for key indicators. The most detailed technical information, and that most applicable to site management, will be reported for individual sanctuaries.

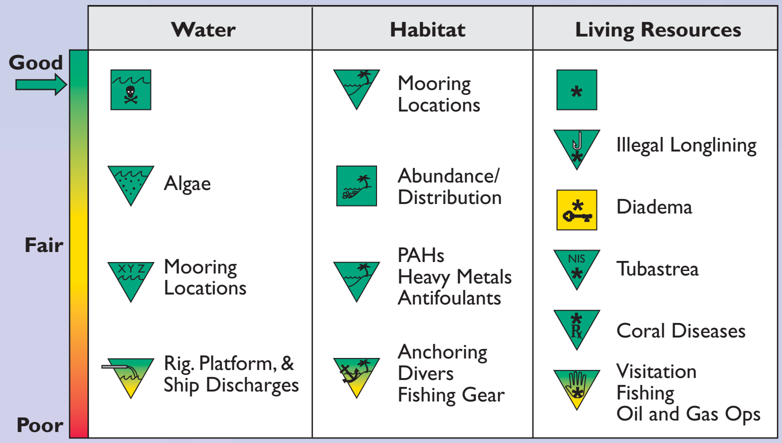
One of the reporting methods that the National Marine Sanctuary Program is considering is a method derived from the format used in the NCCR I. This format consists of customized icons that use color (green, yellow, and red) to show status and shapes (squares and upward- or downward-pointing triangles) to show trends. The use of changing colors in the triangular icons provides a forecast of pending condition based on the judgment of analysts, whereas square icons are used to illustrate static conditions. The icons include pictures or symbols that refer uniquely to elements that affect or compose the sanctuary system. This report card approach summarizes detailed monitoring results for specific sites and provides useful information to audiences with a general interest in marine sanctuaries.





Existing data were used to generate an example of this type of report for the Flower Garden Banks National Marine Sanctuary in the northwest Gulf of Mexico. The diagram below illustrates the good overall condition of the bank's reef resources, as well as several areas of concern to sanctuary management. Text adjacent to the icons indicates specific aspects of the environment that analysts deemed responsible for the resource's condition. For example, the mass mortality of a dominant herbivorous sea urchin, *Diadema antillarum*, in the mid-1980s remains a significant potential disruption to the reef ecosystem (indicated by the yellow box). Recovery of *Diadema* populations has not occurred, yet their mass mortality in the mid-1980s has not resulted in significant long-term changes in the Flower Gardens.

Sanctuary Report: Flower Garden Banks NMS



Another concern in the Flower Gardens is that various discharges may threaten sanctuary water and living resources. Charter dive vessels and oil and gas production facilities in the vicinity are the primary sources of the discharges, which include sewage, bilge water, food, and produced water from wells. High levels of scuba diving activity at certain mooring buoy locations also put stress on some reef areas. In addition, illegal fishing in the sanctuary's deeper areas and mechanical damage caused by anchoring, tow cables, and fishing gear present additional potential threats to the system. Although most of these activities have had minimal consequences on the sanctuary thus far, sanctuary staff are taking steps to characterize and monitor certain contaminants that may act as indicators of problems, and to monitor particular locations because trends indicate that changes may occur in the near future.

Additional information on the National Marine Sanctuary Program is available at http://sanctuaries.noaa.gov/.

Fish Consumption Advisories

A total of 82 fish consumption advisories were in effect for estuarine and coastal marine waters of the United States in 2002, including 74% of the coastal waters of the contiguous 48 states (Figure 2-23). In addition, 30 fish consumption advisories were in effect in the Great Lakes and their connecting waters. An advisory may represent one waterbody or one type of waterbody within a state's jurisdiction, or one or more species of fish. Some of the advisories are issued as single statewide advisories for all coastal estuarine or marine waters within the state (Table 2-5). Although the statewide coastal advisories have placed a large proportion of the nation's coastal waters under advisory, these advisories are often issued for the larger size-classes of predatory species (such as bluefish and king mackerel) because larger, older individuals have had more time to be exposed to and accumulate one or more chemical contaminants in their tissues than have younger individuals.

The yellowtail snapper (*Ocyurus chrysurus*), abundant in the waters of the Florida Keys, is the center of a large commercial and recreational fishing industry. Found in the water column above the reef, this is usually one of the first species a diver or snorkeler will see upon entering the water. (photo: Jim Raymont - Florida Keys NMS)

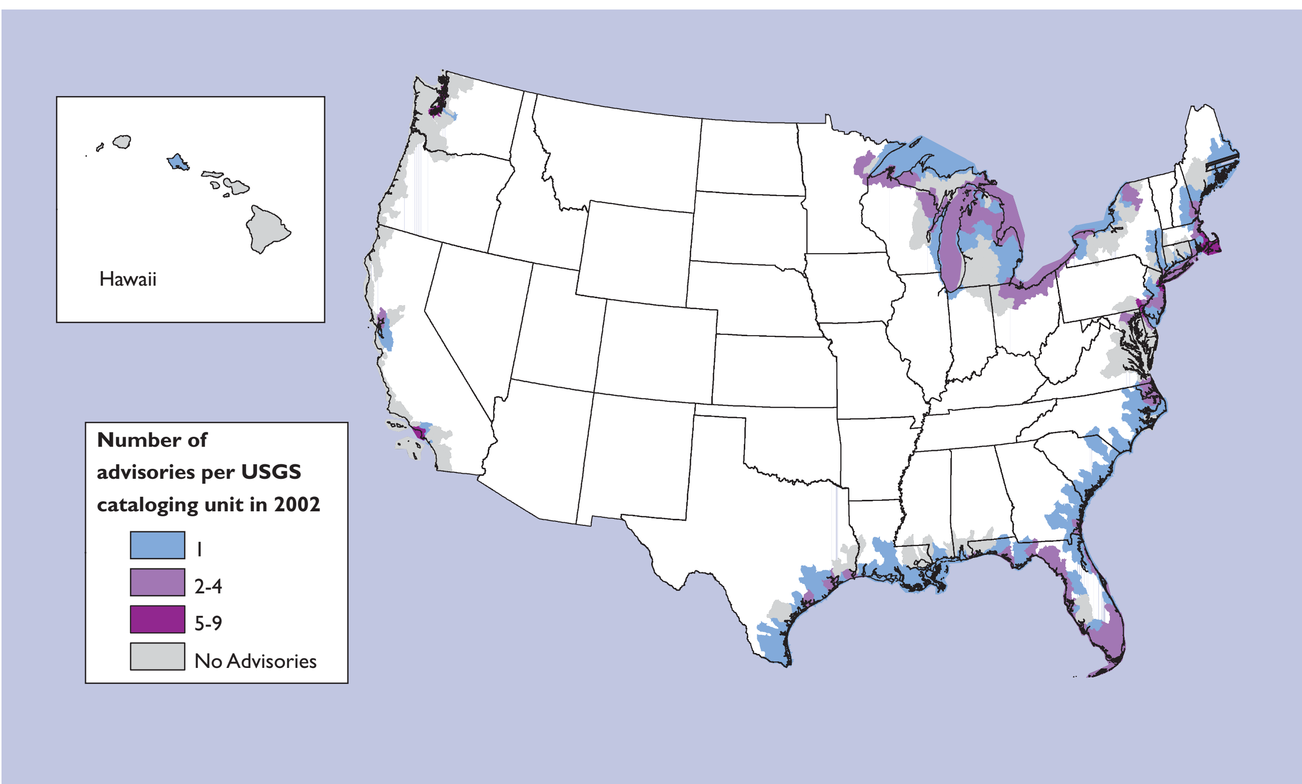


Figure 2-23. The number of coastal and estuarine fish consumption advisories per USGS cataloging unit. This count does not include advisories that may exist for noncoastal or nonestuarine waters. Alaska did not report advisories for 2002 (U.S. EPA, 2003c).

Table 2-4. Summary of States with Statewide Advisories for Coastal and Estuarine Waters (U.S. EPA, 2003c)

State	Pollutants	Species under Advisory
Alabama	Mercury	King mackerel
Connecticut	PCBs	Bluefish Lobster (tomalley) Striped bass
Florida	Mercury	Bluefish Cobia Greater amberjack Jack crevalle King mackerel Little tunny Shark Spotted sea trout
Georgia	Mercury	King mackerel
Louisiana	Mercury	King mackerel
Maine	Dioxins Mercury PCBs	Bluefish Lobster (tomalley) Striped bass
Massachusetts	Mercury PCBs	King mackerel Lobster (tomalley) Shark Swordfish Tilefish Tuna
Mississippi	Mercury	King mackerel
New Hampshire	PCBs	Bluefish Lobster (tomalley) Striped bass
New Jersey	PCBs Cadmium Dioxins	American eel Bluefish Lobster (tomalley) Striped bass
New York	Cadmium Dioxins PCBs	American eel Blue crab (hepatopancreas) Bluefish Lobster (tomalley) Striped bass
North Carolina	Mercury	King mackerel Shark
Rhode Island	PCBs Mercury	Bluefish Shark Striped bass Swordfish
South Carolina	Mercury	King mackerel
Texas	Mercury	King mackerel

The number and geographic extent of advisories can serve as indicators of the level of contamination of estuarine and marine fish and shellfish, but a number of other factors must also be taken into account. For example, the methods and intensity of sampling and the contaminant levels at which advisories are issued often differ among the states. In the states with statewide coastal advisories, one advisory may cover many thousands of square miles of estuarine waters and many hundreds of miles of shoreline waters. Although advisories in U.S. estuarine and shoreline waters have been issued for a total of 23 individual chemical contaminants, most advisories issued have resulted from four primary contaminants. These four chemical contaminants—PCBs, mercury, DDT and its degradation products DDE and DDD, and dioxins/furans—were responsible at least in part for 91% of all fish consumption advisories in effect in estuarine and coastal marine waters in 2002 (Figure 2-24, Tables 2-6 and 2-7). These chemical contaminants are biologically accumulated (bioaccumulated) in the tissues of aquatic organisms to concentrations many times higher than concentrations in seawater (Figure 2-25). Concentrations of these contaminants in the tissues of aquatic organisms may be increased at each successive level of the food web. As a result, top predators in a food web may have concentrations of these chemicals in their tissues that can be a million times higher than the concentrations in seawater. A direct comparison of fish advisory contaminants and sediment contaminants is not possible because states often issue advisories for groups of chemicals; however, five of the top six contaminants associated with fish advisories (PCBs, DDT, dieldrin, chlordane, and dioxins) are among the contaminants most often responsible for a Tier 1 National Sediment Inventory classification (associated adverse effects to aquatic life or human health are probable) of waterbodies based on potential human health effects (U.S. EPA, 1997).

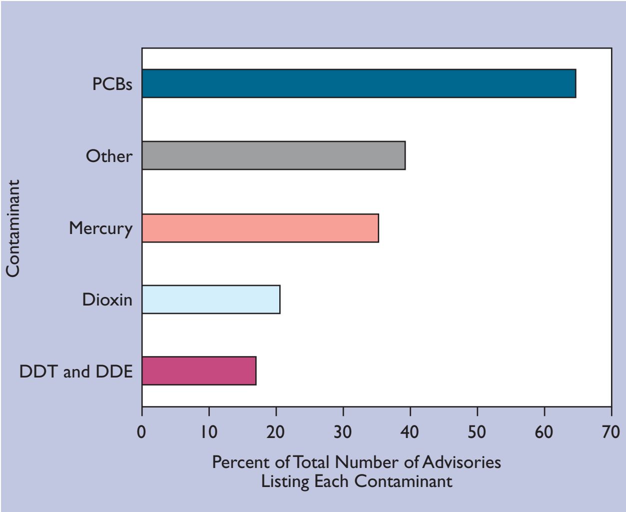


Figure 2-24. Percentage of estuarine and coastal marine advisories issued for each contaminant. An advisory can be issued for more than one contaminant, so percentages may not add up to 100 (U.S. EPA, 2003c).

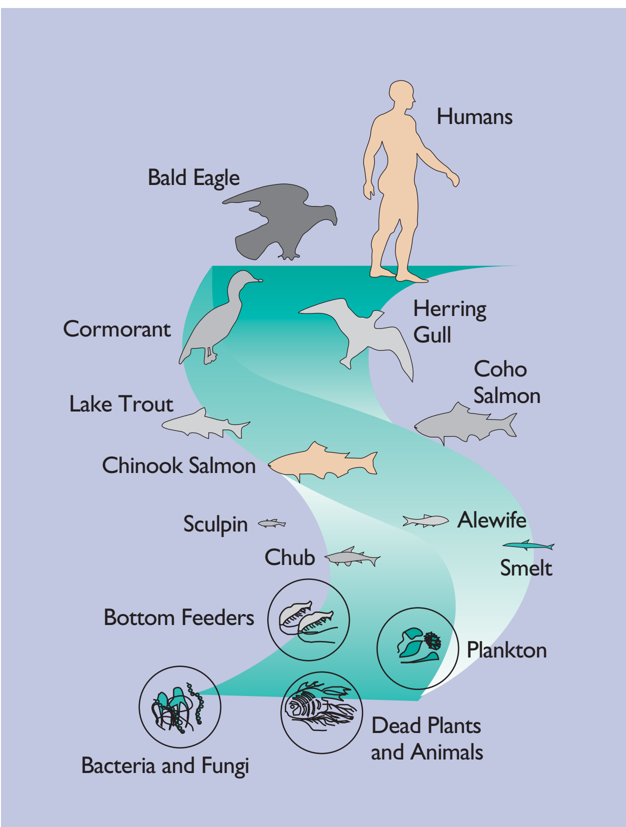


Figure 2-25. Bioaccumulation process (U.S. EPA, 1995).

Table 2-5. The Four Bioaccumulative Contaminants Responsible, at Least in Part, for 91% of Fish Consumption Advisories in Estuarine and Coastal Marine Waters in 2002 (U.S. EPA, 2003c)

Contaminant	Number of Advisories	Comments
PCBs	53	Seven northeast states (CT, MA, ME, NH, NJ, NY, and RI) had statewide PCB advisories, and seven states and the Territory of American Samoa had advisories for specific portions of their coastal waters.
Mercury	29	Eleven states (AL, FL, GA, LA, MA, ME, MS, NC, RI, SC, and TX) had statewide mercury advisories in their coastal waters; six of these states also had statewide mercury advisories for their estuarine waters. Seven states and the Territory of American Samoa had advisories for specific portions of their coastal waters.
DDT, DDE, and DDD	14	All DDT advisories were issued in California (12), Delaware (1), and the Territory of American Samoa (1).
Dioxins	12	Statewide dioxin advisories were in effect in three states (ME, NJ, and NY). Five states had dioxin advisories for specific portions of their coastal waters.

Table 2-6. The Four Bioaccumulative Contaminants Responsible, at Least in Part, for 91% of Fish Consumption Advisories in Estuarine and Coastal Marine Waters in 2002 (Great Lakes) (U.S. EPA, 2003c)

Contaminant	Number of Advisories	Comments
PCBs	30	Eight states (IL, IN, MI, MN, NY, OH, PA, and WI) had PCB advisories for all five Great Lakes and several connecting waters.
Mercury	11	Three states (IN, MI, and PA) had mercury advisories in their Great Lakes waters for Lakes Erie, Huron, Michigan, and Superior, and several connecting waters.
DDT, DDE, and DDD	1	One state (MI) had a DDT advisory in effect for Lake Michigan
Dioxins	14	Dioxin advisories were in effect in three states (MI, NY, and WI) that included all five Great Lakes and several connecting waters.

Beach Advisories and Closures

EPA gathered information on the 2002 swimming season at 2,823 beaches nationwide (both coastal and inland) through the use of a voluntary survey. The survey respondents were state agencies and local government agencies from coastal counties, cities, or towns bordering the Atlantic Ocean, Gulf of Mexico, Pacific Ocean, the Great Lakes, and Hawaii, as well as Puerto Rico, the U.S. Virgin Islands, Guam, and the Northern Mariana Islands. A few of these respondents were regional (multiple-county) districts. Data are available only for those beaches for which officials participated in the survey. EPA conducts the survey each year and displays the results on the BEACH Watch Web site at www.epa.gov/OST/beaches. All data cited in this report were derived from data collected by the EPA's BEACH Watch Program during the 2002 swimming season.

EPA's review of coastal beaches (U.S. coastal areas, estuaries, the Great Lakes, and coastal areas of Hawaii and the U.S. territories) showed that, of the 2,823 beaches responding to the survey, 2,031 were marine or Great Lakes beaches. Of these coastal beaches, 581 (or 29%) had an advisory or closing in effect at least once during the 2002 swimming season (Figure 2-26).

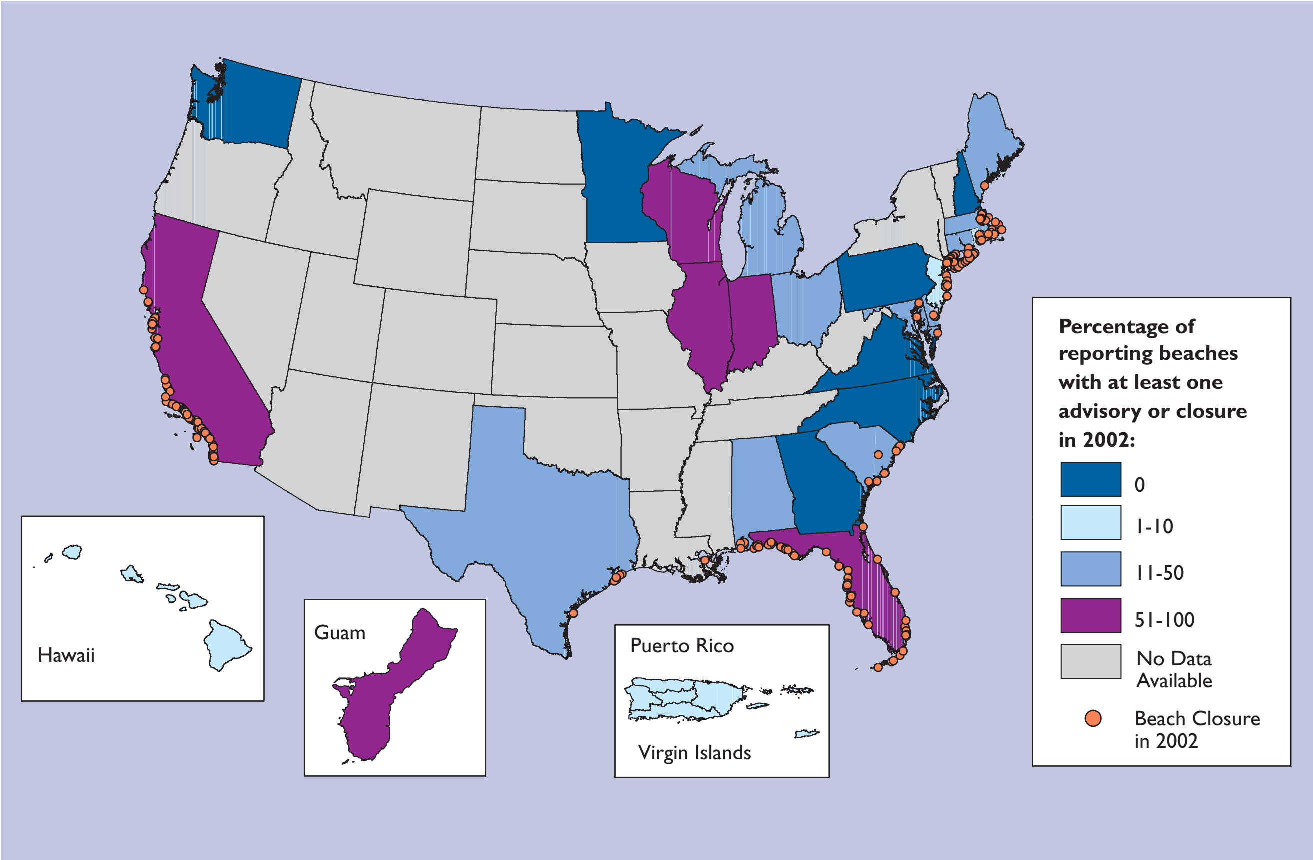


Figure 2-26. Percentage of beaches with advisories/closures by coastal state in 2002. Percentages are based on number of beaches in each state that reported information, not the total number of beaches. There were no BEACH Watch Program survey responses from Alaska, Mississippi, or American Samoa (U.S. EPA, 2003a).

Beach advisories or closings were issued for a number of different reasons, including elevated bacterial levels in the water, preemptive reasons associated with rainfall events or sewage spills, and other reasons (Figure 2-27). Some of the major causes of public notifications for beach advisories and closures were stormwater runoff, wildlife, sewerline problems, boat discharges, publicly owned treatment works (POTWs), and in many cases, unknown sources (Figure 2-28).

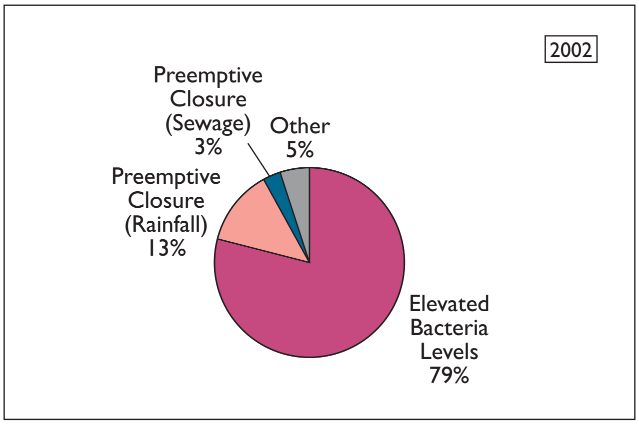


Figure 2-27. Reasons for beach advisories or closures for the nation's coastal waters (U.S. EPA, 2003a).

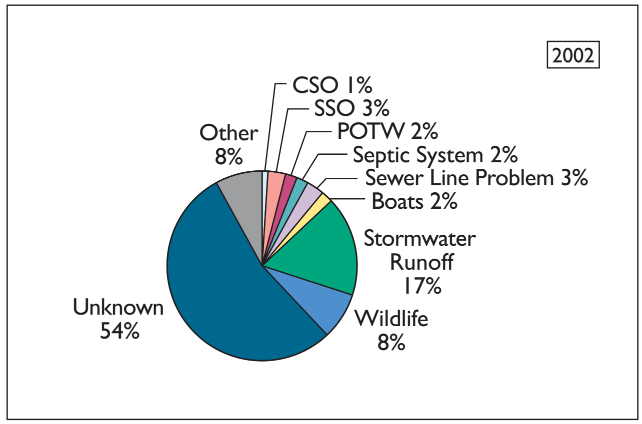


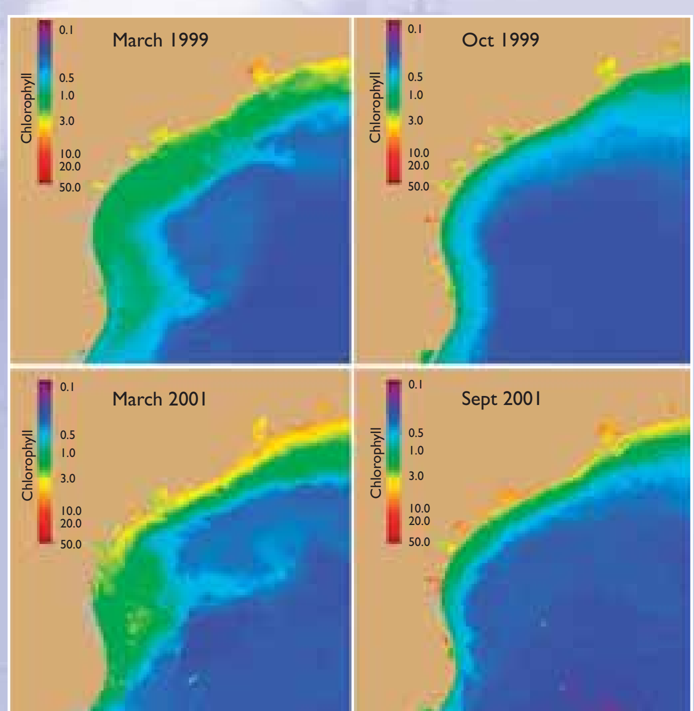
Figure 2-28. Sources of beach contamination for the nation's coastal waters (U.S. EPA, 2003a).

A beach volunteer records the numbers and species of birds present at his designated beach watch. (photo: Gulf of the Farallones NMS)

Sea-Viewing Wide Field-of-View Sensor (SeaWiFS)

The coastal ocean is constantly affected by natural cycles of nutrient and sediment inputs, as well as the impact of increased human population and changing land uses. Rainfall and runoff, usually during the spring, provide nutrients that promote algal blooms. This nutrient flow can affect both estuaries and the coastal ocean. In addition, variations in yearly rainfall can alter the magnitude of algal blooms. Understanding the movement and impact of nutrients and runoff on the coastal zone requires analysis of drainage patterns, pollution transport, concentrations of algae, and sedimentation.

Satellite-borne sensors can provide synoptic data on algae and sediments over large areas, greatly enhancing field programs. A key tool for this application is the Sea-Viewing Wide Field-of-View Sensor (SeaWiFS), which has provided imagery during most cloud-free days over the past 5 years. SeaWiFS was developed by Orbimage to support NASA's global climate programs. With a 1-kilometer pixel size, it can monitor large estuaries and the coastal ocean. NOAA's Center for Coastal Monitoring and Assessment (CCMA) has developed new methods for analyzing SeaWiFS data that have allowed it to be used to assess the coastal zone. For instance, the SeaWiFS images above show the seasonal difference in the Texas coast for two different years, 1999 and 2001. A spring algal bloom is evident in March of both years, with higher chlorophyll along the coast. However, conditions vary between years, with chlorophyll concentrations greater in 2001 than in 1999 for both spring and fall. Precipitation in the region was also higher in 2001 than in 1999. The CCMA is examining these patterns in detail for the entire U.S. coastal area for September 1997 to present in order to determine patterns and variability along the coast.



Source: Holderied et al., 2003

For more information, visit http://ccma.nos.noaa.gov/rsd/welcome.html.

Microbial Source Tracking

Urbanization has caused increased point and nonpoint source runoff into estuaries and may increase fecal coliform pollution. Shellfish harvesting areas are opened or closed based on the number of fecal coliforms, mainly *E. coli*, present in seawater and shoreline surveys that identify sources of fecal contamination. These indicators protect the public from disease-causing microorganisms associated with human waste. Unfortunately, fecal coliform standards for shellfish harvesting are sometimes exceeded when no obvious source of contamination can be identified. This often results in shellfish harvesting areas being closed without a specific identified pollution source.

Bacterial pollution sources within coastal areas have three general sources: wildlife, domestic animals, and humans. Fecal coliforms quantified using traditional approaches can be from any of those sources, but human illnesses have generally been only associated with bacterial pollution from human sources. One method that has been developed as a potential technique for bacteria source tracking is the use of antibiotic resistance testing of *E. coli* bacteria. The rational of this method is that fecal coliform bacteria from humans will have acquired multiple antibiotic resistance (to three or more antibiotics) due to the large number of antibiotics used in medical treatment. Wildlife generally will not harbor antibiotic resistant pathogens due to the absence of their use in wildlife species. Domestic animals (e.g., cattle, hogs, and chickens) and pets will generally be more intermediate in their overall antibiotic resistance.

The Urbanization in Southeast Estuarine Systems (USES) study has evaluated the impact of urbanization on estuarine water quality in terms of fecal coliform bacterial effects by comparing water quality in highly urbanized Murrells Inlet and pristine North Inlet in coastal South Carolina. Significant differences were found between these areas in fecal coliform densities and bacterial species comprising the coliform group. Elevated fecal coliform densities were found in the inner and outer regions of the urban estuary, and *E. coli* accounted for 83% of all bacterial species. In pristine North Inlet, the highest coliform densities were found in the inner regions, adjacent to deciduous hardwood forest, and wildlife were the primary pollution source. *E. coli* was the dominant bacterial species detected, but only accounted for 59% of all bacterial species present. Nonetheless, *E.coli* was the dominant species in the coliform group in surface waters of both areas, and it was not possible on that basis alone to identify pollutant sources.

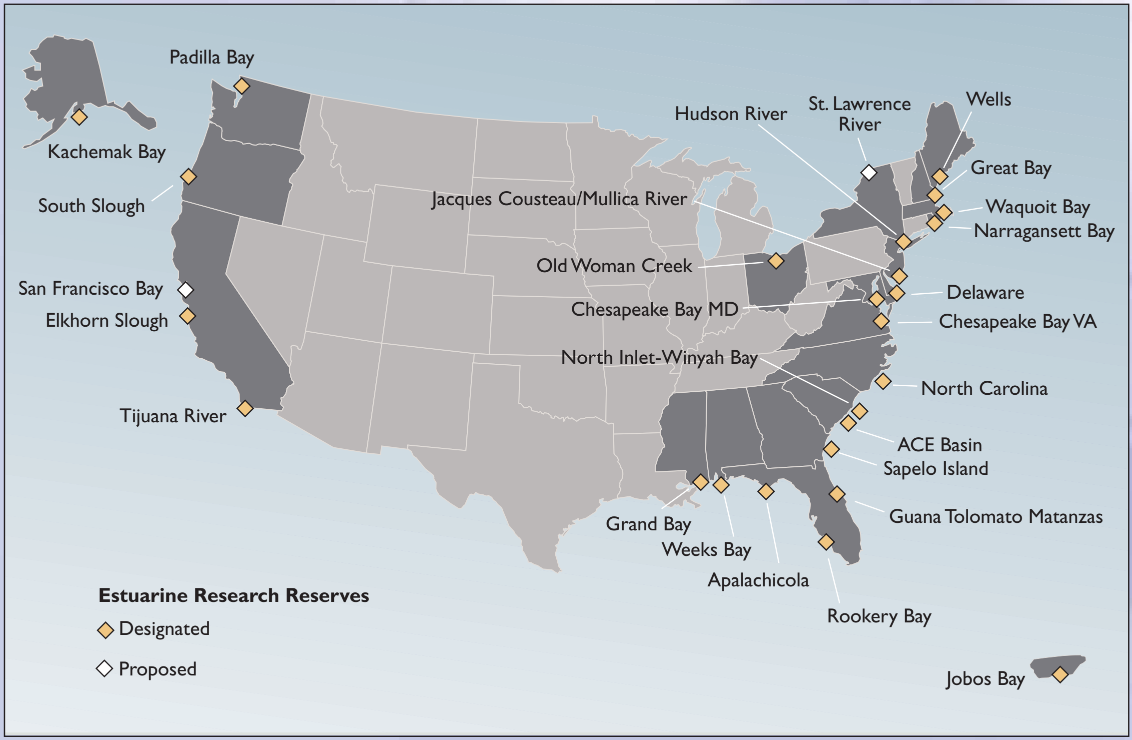
The Multiple Antibiotic Resistance (MAR) method was able to differentiate among pollution sources. MAR results found that 2.5% of *E. coli* bacteria in Murrells Inlet were resistant to multiple antibiotics. The majority of sites had resistance to only a single antibiotic (either ampicillin or penicillin). Only one site had MAR that matched human wastewater treatment plant samples within the region, suggesting a human source. These results compared favorably with other highly urbanized coastal regions of South Carolina including Broad Creek in Hilton Head, where 3% of the *E. coli* were antibiotic resistant. MAR was much lower (<1%) in a rural watershed in Beaufort County, the Okatee River, and in North Inlet. In addition, the MAR index values in urbanized Murrells Inlet (2.47) and Broad Creek (3.40) were higher than in the rural Okatee River (1.04) or North Inlet (<1) watersheds. Similarly, the total number of antibiotics to which *E. coli* exhibited resistance was much higher in urbanized Murrells Inlet (8 antibiotics) and Broad Creek (8 antibiotics), when compared to rural Okatee River (2 antibiotics). Analysis of "Presumptive" Total Maximum Daily Load (TMDL) estimates indicated that the remaining human waste load for Murrells Inlet was less than 1% of the pet waste load estimated for dogs and cats. These findings, when taken in toto for Murrells Inlet, suggest that the vast majority of bacteria in Murrells Inlet is from domestic animals rather than human sources. Thus, to reduce fecal coliform loadings in Murrells Inlet and other coastal areas, it will be important to develop programs to control pet waste loads.

Bacterial closure sign prohibiting shellfish harvesting. This single issue is often a lightning rod at galvanizing public response to changes in environmental conditions within coastal areas.

highlight

Condition of the National Estuarine Research Reserve System

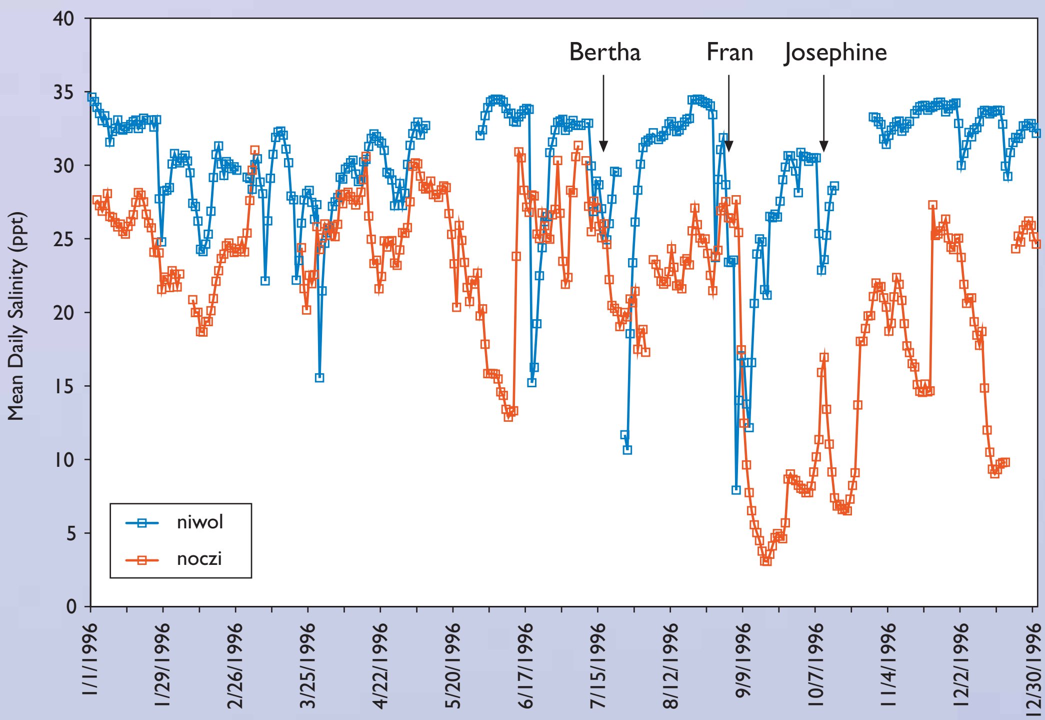
The National Estuarine Research Reserve System (NERRS) is a network of 25 protected areas representing different biogeographic regions of the United States. These protected areas, or reserves, are estuarine areas established to promote long-term research, environmental monitoring, education, and coastal stewardship. NERRS was established by the Coastal Zone Management Act of 1972, as amended, and is a partnership program between NOAA and the coastal states. NOAA provides funding and national guidance, and a lead state agency or university is responsible for managing the reserve with input from local partners.



Prepared by NOAA's Ocean Service, Estuarine Reserves Division, for the National Coastal Condition Report I.

In the mid-1990s, NERRS initiated a monitoring program to improve coastal zone management. The SWMP tracks short-term variability and long-term changes in coastal ecosystems represented in the NERRS. The initial phase of the SWMP began in 1996 and focuses on monitoring of water quality and atmospheric parameters. Future phases of the program will include biodiversity monitoring and land use habitat-change analyses.

The data collected by the program thus far have been used to measure the success of restoration projects and to analyze water quality conditions related to oyster diseases. NERRS has conducted two assessments on water quality data collected through the SWMP. These assessments evaluated water quality data from 22 of the 25 NERRS between 1995 and 2000 and analyzed different aspects of the data collected, including the frequency and duration of hypoxic events, ecosystem metabolism, and the impacts of coastal storms on water quality. Reports documenting the methods and results from these assessments can be downloaded from http://www.ocrm.nos.noaa.gov/nerr/monsys.html. Results from the North Carolina and North Inlet–Winyah Bay, South Carolina, estuaries showed that short-term changes to salinity and depth during the passage of tropical storms were variable and dependent on the fetch (area over which the winds blew) of approaching storms. With a few exceptions for salinity, changes to water quality parameters were abrupt and short-lived.



Effect of storms on mean daily salinity at the North Carolina (noczi) and North Inlet–Winyah Bay (niwol), South Carolina, NERRS sites in 1996 (Sanger et al., 2002).

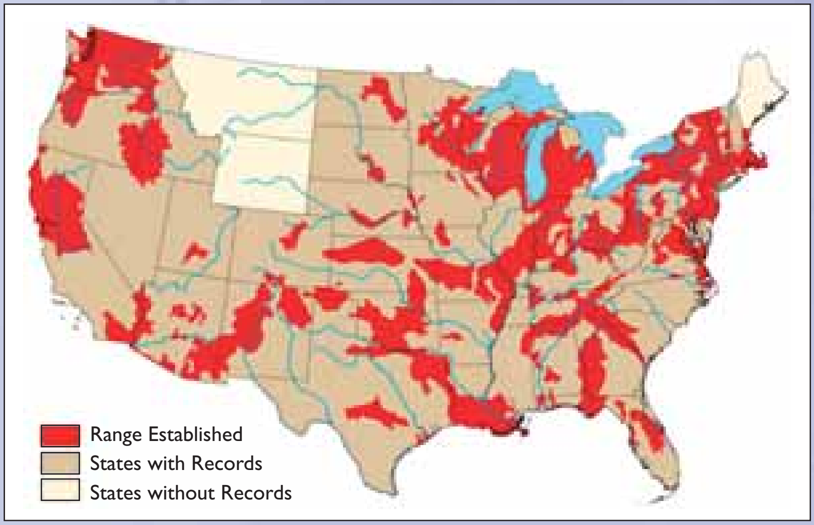
More information about the NERRS program is available at http://www.ocrm.nos.noaa.gov/nerr. Monitoring data for each reserve are available from NERR's Centralized Data Management Office at http://cdmo.baruch.sc.edu.

highlight

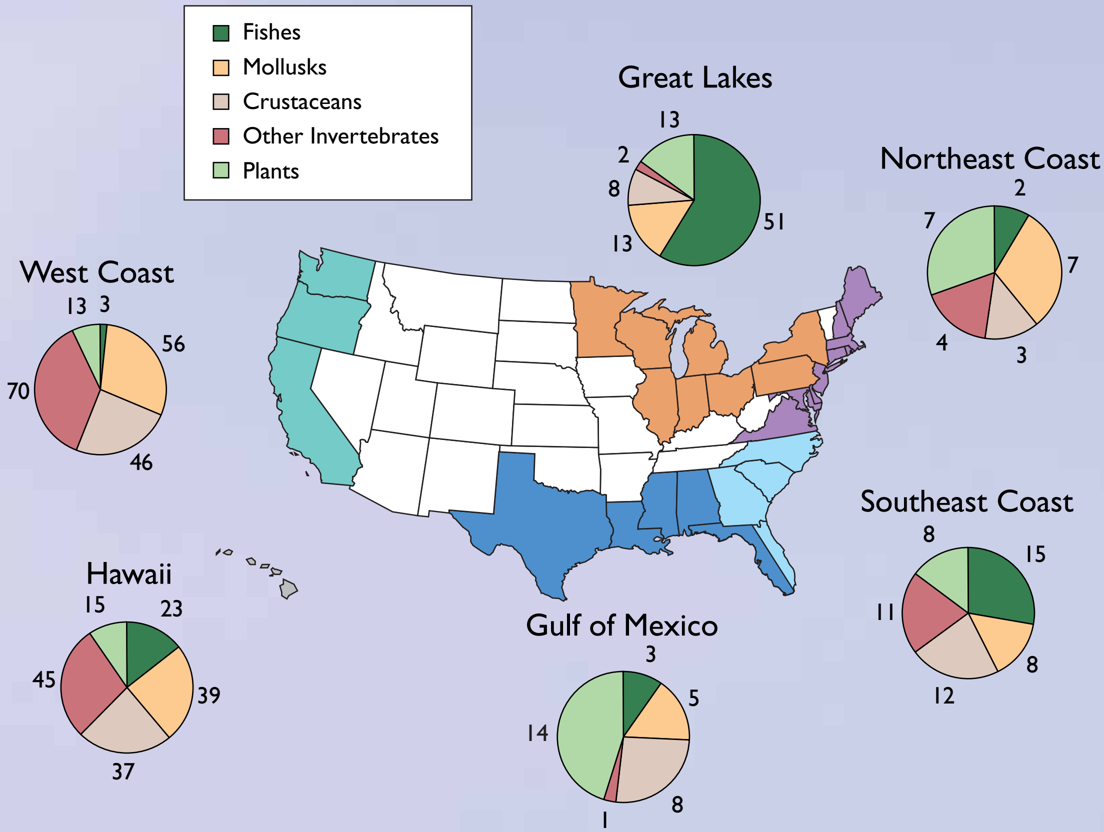
Nonindigenous Species

Nonindigenous species, also known as "exotics" because they are often transported from other countries, are a major threat to biodiversity around the world. The daily inundation of nonindigenous species on the nation's coastlines is a continual concern to environmentalists. Many of the species are transported to the United States by foreign ships, which discharge millions of gallons of ballast water at large commercial shipping ports. Ballast discharges release everything from bacteria and viruses to mussels, crabs, fish, and algae. Although some species do not survive the long voyage, others do, and as ships get faster, the survival rate of these exotic species increases.

The West Coast of the United States, particularly San Francisco Bay, has a very large number of nonindigenous species. One reason for this is that the United States engages in a tremendous amount of trade with Asian countries, and this trade brings many nonindigenous species of Asian origin to the West Coast. Also, San Francisco Bay is a large estuary that is sheltered from the dynamic wave action of the open ocean, and although the West Coast seems to have more nonindigenous species than the East Coast, many more surveys have been conducted along the West Coast to determine what exotic species are present. Recently, however, scientists have been looking at the major ports and estuaries of the East Coast and Gulf of Mexico to obtain similar information. Intracoastal transfer of exotic species is also a concern. Progress is being made in ballast water research and legislation to significantly reduce the number of living organisms being transported from overseas.



Myriophyllum spicatum distribution in the United States as of April 2003. Map indicates recorded presence in at least one site within the drainage, but does not necessarily imply occurrence throughout that drainage (USGS).



Number of nonindigenous species by taxa in coastal regions of the United States (USGS).

Although many nonindigenous species were transported by ships, most aquatic plants known to be invasive did not arrive in ship ballast water, but were imported intentionally through the aquarium and water garden trade. Submerged aquatic vegetation has a well-founded reputation of vigorous invasiveness and can become permanently established where introduced. Eurasian water-milfoil (*Myriophyllum spicatum*) is a prime example. In the United States, Eurasian water-milfoil grows in every state except Alaska, Hawaii, Maine, Montana, and Wyoming. Although it has long been established in freshwater lakes and rivers of the Northeast and Great Lakes regions, this plant is a newcomer to arid western states, where aquatic systems are often stressed and vulnerable. In many estuarine rivers, fresh to brackish marshes, tidal creeks, and protected bays scattered along the Atlantic, Gulf, and Pacific coasts, the Eurasian water-milfoil has thrived and has often become the dominant submerged aquatic plant.

Information about coordinated agency efforts against nonindigenous species can be found at www.anstaskforce.gov. The USGS maintains a geographic database of nonindigenous aquatic species for the United States at http://nas.er.usgs.gov. For more information, contact Amy Benson at amy_benson@usgs.gov.